Inter (Part-I) 2019

Chemistry	Group-II	PAPER: I
Time: 2.40 Hours	(SUBJECTIVE TYPE)	Marks: 68

SECTION-I

2. Write short answers to any EIGHT (8) questions: (16)

(i) Define isotopes. Why they have same chemical properties?

Ans Atoms of the same element can possess different masses but same atomic numbers. Such atoms of an element are called isotopes. So isotopes are different kind of atoms of the same element having same atomic number, but different atomic masses. The isotopes of an element possess same chemical properties and same position in the periodic table, because isotopes have same number of protons and electrons but they differ in the number of neutrons present in their nuclei.

(ii) What is mass spectrum?

Ans Mass spectrum is the plot of data in such a way that (m/e) is plotted as abscissa (x-axis) and the relative number of ions as ordinate (y-axis).

(iii) Molecular formula is nth multiple of empirical formula. Explain with an example.

Ans That formula of a substance which is based on the actual molecule is called molecular formula. It gives the total number of atoms of different elements present in the molecule of a compound. For example, molecular formula of benzene is C_6H_6 while that of glucose is $C_6H_{12}O_6$.

The empirical formulas of benzene and glucose are CH and CH_2O, respectively. So, for these compounds, the molecular formulas are simple multiple of empirical formulas. Hence,

Molecular formula = n(Empirical formula)

where n is the simple integer.

The value of "n" is the ratio of molecular mass and empirical formula mass of substance.

n = Molecular mass / Empirical formula mass

(iv) How can rate of filtration be increased by fluted filter paper?

Ans The rate of filtration through conical funnel can be considerably increased using a fluted filter paper. For preparation of such paper, ordinary filter paper is folded in such a way that a fan-like arrangement with alternate elevations and depressions at various folds is obtained.

(v) Define ether extraction.

Ans A method of extracting a desired component from the solution by shaking it with a second liquid in which component is more soluble and which is immiscible with the first liquid is called solvent extraction.

The most common laboratory example of solvent extraction is ether extraction. This is used to separate the products of organic synthesis from water.

The technique is particular useful when the product is volatile or thermally unstable.

(vi) Calculate the value of general gas constant (R) in SI units.

Ans **Value of R in SI unit:**

For calculating the value of R, we must consider the S.I units of pressure, volume, temperature.

S.I unit of pressure = Nm^{-2}

S.I unit of temperature = K

S.I unit of volume = m^3

1 atm = 760 torr = 101325 Nm^{-2}

1 m^3 = 1000 dm^3

n = 1 mole

T = 273.16 K

P = 1 atm = 101325 Nm^{-2}

V = 22.414 dm^3 = 0.022414 m^3

Putting their values along with units.

From PV = nRT, we get

$$R = \frac{PV}{nT}$$

$$R = \frac{101325\ Nm^{-2} \times 0.022414\ m^3}{1\ mol \times 273.16\ K}$$

$$R = 8.3143\ Nm\ K^{-1}\ mol^{-1}$$

$= 8.3143 \text{ J K}^{-1} \text{ mol}^{-1}$ (1 Nm = 1 J)

Since, 1 cal. = 4.18 J

So, $R = \dfrac{8.3143}{4.18}$

$= 1.989 \text{ cal. K}^{-1} \text{ mol}^{-1}$

(vii) Why do we get straight line, when pressure is plotted against inverse of volume?

Ans When graph is plotted between $\frac{1}{V}$ on x-axis and pressure "P" on the y-axis, then a straight line is obtained.

Reason:

In Boyle's law, the pressure and the inverse of volume are directly proportional to each other.

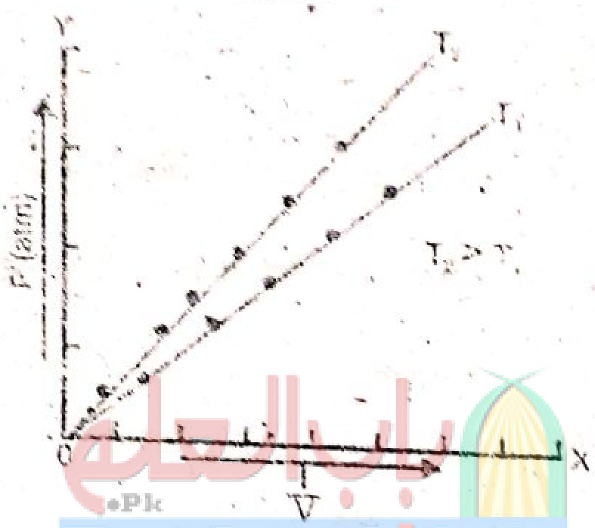

Fig. A plot between P and $\frac{1}{V}$.

(viii) Why lighter gases diffuse more rapidly than heavier gases?

Ans Lighter gases diffuse more rapidly than heavier gases due to density. According to Graham's law,

"The rate of diffusion of two gases is inversely proportional to the square root of their molecular masses or densities at constant temperature and pressure."

(ix) State Joule-Thomson effect:

Ans "When highly compressed gas is allowed to expand into low pressure region, it causes cooling. This is called Joule-Thomson effect."

This method is used for cooling in refrigerators, ice factories, air-conditioners, etc.

(x) How will you prepare 10% w/v glucose solution in water?

Ans **Percentage Weight / Volume:**

It is the weight of a solute dissolved per 100 parts by volume of solution. 10 g of glucose dissolved in 100 cm^3 of solution is 10% w/v solution of glucose. The quantity of the solvent is not exactly known. In such solutions, total volume of the solution is under consideration.

(xi) One molal solution of urea is dilute as compared to one molar solution. Justify.

Ans In one molal solution of urea, 60 g of urea is dissolved in 1000 g of water, which is approximately 1000 cm^3 of water. In one molar solution of urea, 60 gm of urea is added in water to make total volume of solution as 1000 cm^3. So the volume of water in molar solution is less than 1000 cm^3. Hence molar solution is concentrated and molal solution is dilute.

(xii) Define molarity. How is molarity related to mass of solute?

Ans Molarity is the number of moles of solute dissolved per dm^3 of the solution.

$$M = \frac{\text{Mass of solute}}{\text{Mol. mass of solute}} \times \frac{1}{\text{Volume of solution}}$$

or $$M = \frac{\text{Number of moles of solute}}{\text{Volume of solution } dm^3}$$

3. Write short answers to any EIGHT (8) questions: (16)

(i) Boiling point of water is greater than boiling point of HF, although hydrogen bonding is stronger in HF than in H_2O. Why?

Ans In water, each molecule can make two hydrogen bonds with two neighbouring water molecules. In this way, the links of H_2O molecule are greater. In case of HF, there is only one partial positive hydrogen which can make only one H-bond with other fluorine atom. Therefore, boiling point of H_2O is greater than that of HF.

(ii) Evaporation is a cooling process. Justify.

Ans Evaporation causes cooling because when high energy molecules leave the liquid and low energy molecules are left behind, the temperature of liquid falls and heat moves from surrounding to liquid and then temperature of surrounding also falls.

(iii) Define isomorphism and polymorphism giving one example in each.

Ans **Isomorphism:**

It is a phenomenon in which two different substances exist in the same crystalline form. These different substances are isomorphs.

e.g., $NaNO_3$, KNO_3 ⟶ rhombohedral

Zn, Cd ⟶ hexagonal

Cu, Ag ⟶ cubic

Polymorphism:

It is a phenomenon in which a compound exists in more than one crystalline form. That compound which exists in more than one crystalline form is polymorphic, and these forms are called polymorphs of each other.

e.g., $AgNO_3$ exists in rhombohedral and orthorhombic forms.

(iv) Write two applications of liquid crystals.

Ans Following are the two applications of liquid crystals:

1. In chromatographic separations, liquid crystals are used as solvents.
2. Oscillographic and TV displays also use liquid crystal screens.

(v) Write nuclear reaction for the production of neutron.

Ans The nuclear reaction is as follows:

$$^{4}_{2}He + ^{9}_{4}Be \longrightarrow ^{12}_{6}C + ^{1}_{0}n$$

(α-particle)

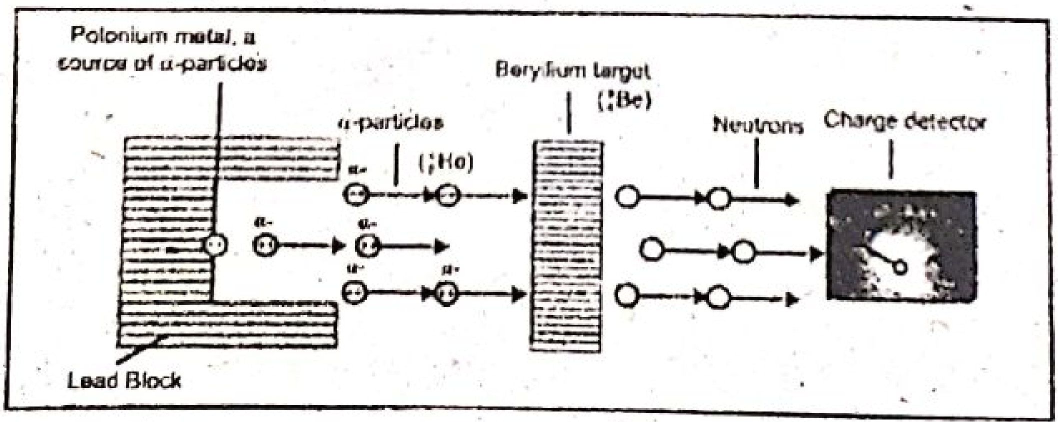

Fig. Bombardment of Be with α-particles and discovery of neutron.

Actually, α-particles and the nuclei of Be ate re-arranged and extra neutron is emitted.

(vi) Write any two points of Planck's quantum theory.

Ans Following are the two points of Planck's quantum theory:

1. Energy is not emitted or absorbed continuously. Rather, it is emitted or absorbed in a discontinuous manner and in the form of wave packets. Each wave packet or quantum is associated with a definite amount of energy. In case of light, the quantum of energy is often called photon.
2. The amount of energy associated with a quantum of radiation is proportional to the frequency (ν) of the radiation. Frequency is the number of waves passing through a point per second.

$$E \propto \nu$$

$$E = h\nu$$

Where 'h' is a constant known as Planck's constant and its value is 6.626×10^{-34} Js. It is, in fact, the ratio of energy and the frequency of a photon.

(vii) State Hund's rule, giving an example.

Ans **Hund's Rule:**

If degenerate orbitals are available and more than one electrons are to be placed in them, they should be placed in separate orbitals with same spin rather than putting them in same orbital with opposite spins.

Example:

$$_6C = 1s^{\downarrow\uparrow}\ 2s^{\downarrow\uparrow}\ 2p_x^{\uparrow}\ 2p_y^{\uparrow}\ 2p_z^{0}$$

(viii) Write any two defects of Bohr's atomic model.

Ans Following are the two defects of Bohr's atomic model:

1. It can successfully explain origin of spectrum of H-atom and ions like He^{+1}, Li^{+2}, etc. These are all one-electron systems. But this theory is not able to explain origin of spectrum of multi-electron or poly-electron systems like He, Li, etc.
2. Bohr suggested circular orbits of electrons around nucleus of hydrogen atom, but researches have shown that motion of electron is not in a single plane but takes place in three-dimensional space. The atomic model is not flat.

(ix) Differentiate between reversible and irreversible reactions.

Ans

Reversible reactions	Irreversible reactions
1. A reversible reaction is that one in which products of a reaction can react to form the original reactants.	1. An irreversible reaction is that in which products of the reaction do not react to form the original reactants under the same sets of conditions.
2. It is bidirectional and constitute a limiting case between spontaneous and non-spontaneous processes.	2. It is unidirectional and spontaneous process.
3. Example: $NaOH + HCl \rightleftharpoons NaCl + H_2O$	3. Example: $CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$

(x) How are acidic buffer and basic buffer prepared? Give one example in each case.

Ans By mixing a weak acid and its salt with a strong base, acidic buffers are produced with pH less than 7. Mixture of acetic acid and sodium acetate is one of the best examples of such a buffer.

By mixing a weak base and its salt with a strong acid, basic buffers are prepared with pH more than 7. Mixture of NH_4OH and NH_4Cl is one of the best examples of such a basic buffer.

(xi) Define catalysis. Give its different types with one example in each case.

Ans A catalyst is a substance which alters the rate of a chemical reaction, but remains chemically unchanged at the end of the reaction.

The process, which takes place in the presence of a catalyst, is called catalysis.

It has two types:

(a) Homogeneous Catalysis:

In this process, the catalyst and the reactants are in the same phase and the reacting system is homogeneous throughout. For example: Formation of SO_3.

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{NO_{(g)}} 2SO_{3(g)}$$

(b) Heterogeneous Catalysis:

In such systems, the catalyst and the reactants are in different phases. For example, Oxidation of ammonia to NO in the presence of platinum gauze helps us to manufacture HNO_3.

$$4NH_{3(g)} + 5O_{2(g)} \xrightleftharpoons{Pt_{(s)}} 4NO_{(g)} + 6H_2O_{(g)}$$

(xii) Justify that rate of chemical reaction is an ever changing parameter under the given conditions.

Ans When the reaction progresses, the reaction is very fast at the beginning, slow somewhere in the middle and very very slow at the end. The reason is that rate depends upon concentrations according to law of mass action. The concentrations decrease every moment, so rate decreases with the passage of time.

4. Write short answers to any SIX (6) questions: (12)

(i) Explain geometry of H_2S molecule on the basis of VSEPR theory.

Ans Two of the corners of a tetrahedron are occupied by each of the two lone pairs and the remaining by bond pairs. But owing to spatial arrangement of lone pairs and their repulsive action among themselves and on bond pairs, the bond angle in H_2S is further reduced to 104.5°. The geometry is bent or angular tetrahedral.

(ii) Define ionization potentials of elements. How the ionization potential vary across the periods?

Ans The ionization energy of the element is the minimum energy required to remove an electron from its gaseous atom to form an ion.

$$Mg \longrightarrow Mg^+ + e^- \qquad \Delta H = 738 \text{ kJ mol}^{-1}$$

In the gaseous phase, the atoms and ions are isolated and are free from all external influences. The ionization energy is the qualitative measure of the stability of an isolated atom.

In the periodic table, the ionization energies increase from left to right in a period with the increase in the proton number, until a maximum value is reached at the end of the period.

This is due to successive addition of electronic shells as a result of which the valence electrons are placed at a larger distance from the nucleus. As the force of attraction between

the nucleus and the outer electron decreases with the increase in distance, the electron can be removed more easily or with less energy. Moreover, the force of attraction also decreases due to increasing shielding effect of the intervening electrons.

(iii) Cationic radius is smaller than that of its parent atomic radius. Why?

Ans The cationic radius decreases with the increase in the effective nuclear charge on the ion. The decrease in radius is larger for divalent ions (Mg^{2+}) and still larger for trivalent ions (Al^{3+}). This is due to the reason that with the successive loss of electrons, the nuclear charge attracts the remaining electrons with a greater force. The radius of Na atom, for example, reduces from 186 pm to 95 pm after conversion into Na^+ ion.

(iv) Differentiate between bonding and anti-bonding molecular orbitals with reference to relative energies and symmetry of electronic clouds (no figure required).

Ans The molecular orbital surrounds two or more nuclei of the bonded atoms. Two atomic orbitals, after overlapping, form two molecular orbitals which differ in energy. One of them, having lower energy, is called bonding molecular orbital, while the other, having higher energy is called anti-bonding molecular orbital. The bonding molecular orbital is symmetrical about the axis joining the nuclei of the bonded atoms (molecular axis). The bonding molecular orbital is designated as sigma (σ), while the anti-bonding molecular orbital is called σ^*.

(v) Define state function. Write name of two such functions.

Ans **State function:**

A state function is a macroscopic property of system which has some definite values for initial and final states and which is independent of path adopted to bring about a change.

Example:

→ Temperature (T)

→ Volume (V)

(vi) Burning of natural gas is spontaneous reaction. Justify.

Ans All the processes that proceed with the decrease in energy of the system (exothermic) are spontaneous. A spontaneous process or reaction is unidirectional, irreversible and real. Due

to spontaneity, the reaction attains the equilibrium stage and it will not change until disturbed by some external aid.

The burning of CH_4 in the air produces heat which is used for cooking and running industries.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

A reaction will also be called a spontaneous process, if it needs energy to start with, but once it is started, then it proceeds on its own. Burning of natural gas in air is example of such spontaneous reactions. It does not burn in air on its own rather the reaction is initiated by a spark and once coal starts burning, then the reaction goes spontaneously to completion.

(vii) What are secondary cells? Write name of any two such cells.

Ans Those cells which can be recharged are called secondary cells. Examples are lead-acid battery, Ni-Cd battery and fuel cells.

(viii) Describe function of salt bridge in a voltaic cell.

Ans The purpose of the salt bridge is to prevent any net charge accumulation in either beaker by allowing negative ions to leave the right beaker, diffuse through the bridge and enter the left beaker. If this diffusional exchange of ions does not occur, the net charge accumulating in the beakers would immediately stop the flow of electrons through the external circuit and the oxidation-reduction reaction would stop.

(ix) Define electrode potential.

Ans The potential set up, when an electrode is in contact with one molar solution of its own ions at 298 K is called standard electrode potential or standard reduction potential of the element. It is represented as E^o.

SECTION-II

NOTE: Attempt any Three (3) questions.

Q.5.(a) Write detailed note on: **(4)**

(i) Avogadro's number **(ii) Molar volume**

Ans **(i) Avogadro's number:**

Avogadro's number is the number of atoms, molecules and ions in one gram atom of an element, one gram molecule of a compound and one gram ion of a substance, respectively.

The number 6.02×10^{23} refers to one mole of a substance. This number is called Avogadro's number and it is denoted by N_A.

The required equation is:

$$\text{Number of atoms of an element} = \frac{\text{Mass of the element} \times N_A}{\text{Atomic mass}}$$

(ii) Molar volume:

One mole of any gas at standard temperature and pressure (STP) occupies a volume of 22.414 dm^3. This volume of 22.414 dm^3 is called molar volume and it is true only when the gas is ideal. With the help of this information, we can convert the mass of a gas at STP into its volume and vice versa.

It is very interesting to know from the above data that 22.414 dm^3 of each gas has a different mass but the same number of molecules. The reason is that the masses and the sizes of the molecules do not affect the volumes. Normally, it is known that in the gaseous state the distance between molecules is 300 times greater than their diameters.

(b) Define vapour pressure. Write down manometric method for its determination with diagram. (4)

Ans Definition:

The vapour pressure of a liquid is a pressure exerted by the vapours of the liquid in equilibrium with a liquid at a given temperature.

$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

Manometric method:

Manometric method is comparatively an accurate method. The liquid whose vapour pressure is to be determined is taken in a flask placed in a thermostat, as shown in the Fig. One end of the tube from the flask is connected to a manometer and the other end is connected to a vacuum pump. The liquid is frozen with the help of a freezing mixture and the space above the liquid is evacuated. In this way, the air is removed from the surface of the liquid along with the vapours of that liquid. The frozen liquid is then melted to release any entrapped air. Liquid is again frozen and released air is evacuated. This process is repeated many times till almost all the air is removed.

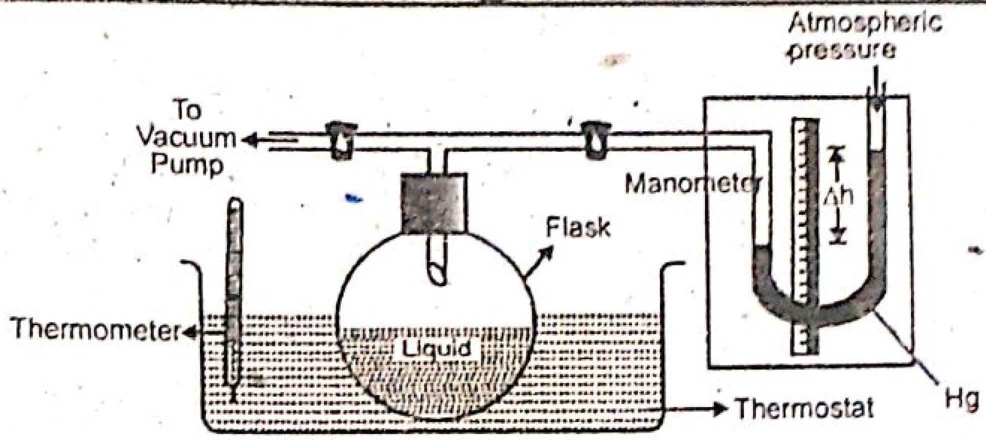

Fig. Measurement of vapour pressure of a liquid by manometric method.

Now, the liquid is warmed in the thermostat to that temperature at which the vapour pressure of the liquid in the flask is to be determined. Difference in the heights of the columns of Hg in the two limbs of the manometer determines the vapour pressure of the liquid.

The column of mercury in the manometer facing the vapours of the liquid is depressed. The other column, which faces the atmospheric pressure, rises. Actually, the pressure on the surface of the liquid in the flask is equal to the sum of the atmospheric pressure and the vapour pressure of liquid. For this reason, the column of manometer facing the liquid is more depressed than facing the atmosphere, and it is given by the following equation

$$P = P_a + \Delta h$$

Where P = Vapour pressure of the liquid at one atm pressure.

P_a = Atmospheric pressure.

Δh = Difference in the heights of the mercury levels in the two limbs of the manometer, giving us the vapour pressure of liquid.

Q.6.(a) A sample of nitrogen gas is enclosed in a vessel of volume 380 cm^3 at 120°C and pressure of 101325 Nm^{-2}. This gas is transferred to 10 dm^3 flask and cooled to 27°C, calculate the pressure in Nm^{-2} exerted by the gas at 27°C. (4)

Ans All the three parameters of this gas have been changed, so we can solve this problem by using the general gas equation of the form:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Preferably, convert the volume to dm^3 and temperature to Kelvin scale.

Initial volume of the gas $(V_1) = 380\ cm^3 = 0.38\ dm^3$

Initial temperature $(T_1) = 120°C + 273\ K = 393\ K$

Initial pressure $(P_1) = 101325\ Nm^{-2}$

Final temperature $(T_2) = 27°C + 273\ K = 300\ K$

Final volume $(V_2) = 10\ dm^3$

Final pressure $(P_2) = ?$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{V_2}$$

$$P_2 = \frac{101325\ Nm^{-2} \times 0.38\ dm^3 \times 300\ K}{393\ K \times 10\ dm^3}$$

$$= \boxed{2938.4\ Nm^{-2}}$$

(b) Write any four properties of cathode rays. (4)

Ans Following are the four properties of cathode rays:

1. Cathode rays can produce X-rays when they strike an anode, particularly with large atomic mass.
2. Cathode rays can produce heat when they fall on matter, *e.g.*, when cathode rays from a concave cathode are focussed on a platinum foil, it begins to glow.
3. Cathode rays can ionize gases.
4. They can cause a chemical change, because they have a reducing effect.

Q.7.(a) Explain the structure of ethyne (C_2H_2) according to hybridization concept. (4)

Ans **sp-Hybridization:**

In sp hybridization, one 's' and one 'p' orbitals intermix to form two sp-hybrid orbital called sp hybrid orbitals.

Ethyne (CH≡CH):

The electronic configuration of ethyne is:

$$\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow}\ \boxed{\uparrow}\ \ o$$

$${}_{6}C \text{ (ground state)} = 1s\ 2s\ 2p_x\ 2p_y\ 2p_z$$

$$\boxed{\uparrow\downarrow}\ \boxed{\uparrow}\ \boxed{\uparrow}\ \boxed{\uparrow}\ \boxed{\uparrow}$$

$${}_{6}C \text{ (excited state)} = 1s\ 2s\ 2p_x\ 2p_y\ 2p_z$$

$$\boxed{\uparrow\downarrow}\ \boxed{\uparrow}\ \boxed{\uparrow}\ \boxed{\uparrow}\ \boxed{\uparrow}$$

$${}_{6}C \text{ (hybridized)} = 1s\ sp^2\ sp^2\ 2p_y\ 2p_z$$

Ethyne is formed as a result of sp hybridization of carbon atoms and subsequent formation of σ and π bonds. Each carbon atom undergoes sp-s overlap with one hydrogen atom and sp-sp overlap with other carbon atom. Each carbon atom is left with two unhybridized p orbitals perpendicular to the plane of sp hybrid orbitals. The two half-filled p orbitals (on separate carbon atoms) are parallel to each other in one plane while the other two p orbitals are parallel to each other in another plane. The sideways π overlap between the p-orbitals in two planes results in the formation of two π bonds as shown in Fig.

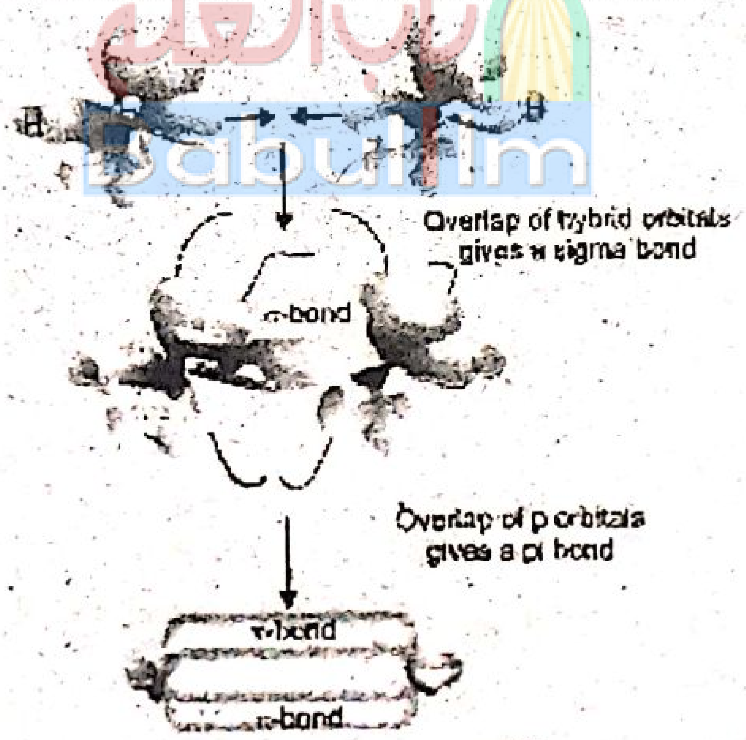

Fig. Formation of one sigma and two pi-bonds in C_2H_2 (ethyne).

Ethyne molecule contains one σ and two π bonds between the two carbon atoms and each carbon atom is bonded with one H atom through a σ bond. Actually, four electronic clouds of two π-bonds intermix and they surround the sigma bond in the shape of a drum.

(b) Explain the following terms: **(4)**

(i) Standard heat of neutralization.

(ii) Standard enthalpy of solution.

Ans **(i) Standard heat of neutralization:**

"The standard enthalpy of neutralization is the amount of heat evolved when one mole of hydrogen ions $[H^+]$ from an acid, reacts with one mole of hydroxide ions $[OH^-]$ from a base to form one mole of water."

For example, the enthalpy of neutralization of sodium hydroxide by hydrochloric acid is -57.4 kJ mol^{-1}. Note that a strong acid, HCl and a strong base, NaOH, ionize completely in dilute solutions as follows:

$$HCl(aq) \rightleftharpoons H^+(aq) + Cl^-(aq)$$

$$NaOH(aq) \rightleftharpoons Na^+(aq) + OH^-(aq)$$

(ii) Standard enthalpy of solution:

"The standard enthalpy of a solution is the amount of heat absorbed or evolved when one mole of a substance is dissolved in so much solvent that further dilution results in no detectable heat change."

For example, enthalpy of solution ($\Delta H^0_{sol.}$) of ammonium chloride is $+16.2$ kJ mol^{-1} and that of sodium carbonate is -25.0 kJ mol^{-1}. In the first case, heat absorbed from the surroundings is indicated by cooling of the solvent (water), an endothermic process. While in the second case, the temperature of the solvent rises showing that the process is exothermic.

Q.8.(a) $Ca(OH)_2$ is a sparingly soluble compound. Its solubility product is 6.5×10^{-6}. Calculate the solubility of $Ca(OH)_2$. **(4)**

Ans For Answer see Paper 2016 (Group-II), Q.8.(a).

(b) Explain the effect of temperature on the rate of reaction. **(4)**

Ans **Effect of Temperature on Rate of Reaction:**

The collision theory of reaction rates convinces us that the rate of a reaction is proportional to the number of collision among the reactant molecules. Anything, that can increase the frequency of collisions should increase the rate. We also know, that every collision does not lead to a reaction. For a collision to be effective the molecules must possess the activation energy and they must also be properly oriented. For nearly all chemical reactions, the activation energy is quite large; and at ordinary temperature, very few molecules are moving fast enough to have this minimum energy.

All the molecules of a reactant do not possess the same energy at a particular temperature. Most of the molecules will possess average energy. A fraction of total molecules will have energy more than the average energy. This fraction of molecules indicated as shaded area in Figure.

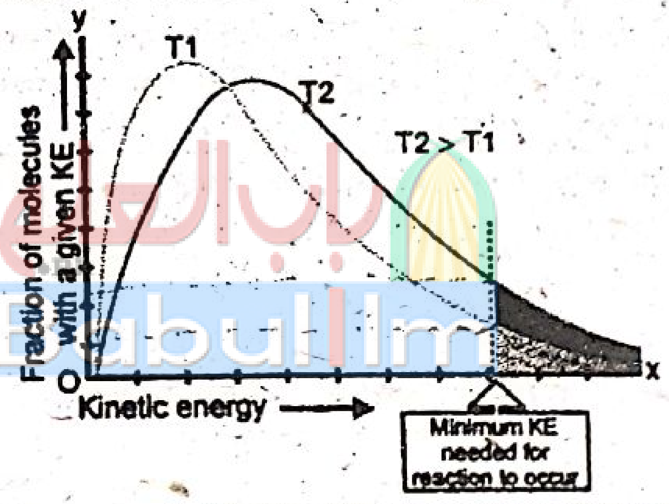

Fig. Kinetic energy distributions for a reaction mixture at two different temperatures. The size of the shaded areas under the curves are proportional to the total fraction of the molecules that possess the minimum activation energy.

As the temperature increases, the number of molecules this fraction also increases. There happens a wider distribu of velocities. The curve at higher temperature T_2 has flatt It shows that molecules having higher energies have incre and those with less energies have deceased. So, the numb effective collisions increases and hence, the rate incre When the temperature of the reacting gases is raised by 1

the fraction of molecule with energy more than E_a roughly doubles and so the reaction rate also doubles. Arrhenius has studied the quantitative relationship between temperature, energy of activation and rate constant of a reaction.

Q.9.(a) Differentiate between ideal and non-ideal solutions. (4)

Ans **Ideal and Non-Ideal Solutions:**

When two or more than two liquid substances are mixed, the solutions may be ideal or non-ideal. To distinguish between such solutions, we look at the following aspects:

(i) If the forces of interactions between the molecules of different components are same as when they were in the pure state, they are ideal solutions, otherwise non-ideal.

(ii) If the volume of solution is not equal to the sum of the individual volumes of the components, the solution is non-ideal.

(iii) Ideal solutions have zero enthalpy change as their heat of solution.

(iv) If the solutions obey Raoult's law, then they are ideal. This is one of the best criterion for checking the ideality of a solution.

(b) Define electrochemical series. Discuss calculation of the voltage of cell, giving one example. (4)

Ans **Electrochemical Series:**

"When elements are arranged in the order of their standard electrode potentials on hydrogen scale, the resulting list is known as electrochemical series."

Calculation of the Voltage or Electromotive Force (emf) of Cells:

In a galvanic cell, the electrode occupying a higher position in electrochemical series will act as anode and oxidation takes place on it. Similarly, the electrode occupying the lower position in the series will act as a cathode and reduction will take place on it. Let us find out a cell potential or the emf of the cell. The half-cell reactions are:

$$Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^- \quad \text{(oxidation half reaction)}$$

$$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \quad \text{(reduction half reaction)}$$

$Cu^{2+}_{(aq)} + Zn_{(s)} \rightarrow Cu_{(s)} + Zn^{2+}_{(aq)}$ (complete cell reaction)

The oxidation potential of Zn is positive. The reduction potential of Cu^{2+} is also positive.

The cell voltage or emf of the cell is given by:

$$E^o_{cell} = E^o_{oxi} + E^o_{red}$$

$$E^o_{cell} = 0.76 + 0.34 = 1.10 \text{ volts}$$

The cell voltage or emf measures the force with which electrons move in the external circuit and, therefore, measures the tendency of the cell reaction to take place. Galvanic cells, thus, give quantitative measure of the relative tendency of the various reactions to occur.